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ABSTRACT

Information processing is discussed as a rapid coalescing of basic disciplines around a point of view with relevance to the reading processes and ultimately to learning to read. Two types of reading models under information processing are analyzed: the O-type model which delineates the organismic systems operating between input and output at a psychological level, and the S-type model which concerns the transformations of the information itself from the printed pattern into meaningful language of a form appropriate to the intended output. These models are conceived of as contributing not directly to reading instruction, but to serve as a seminal focus for further research in a variety of disciplines. Some of these processes unfamiliar to reading teachers should add genuinely new dimensions to the teaching of reading, since they provide a more precise basis for diagnosis and remediation and could serve a taxonomic function for the structuring of individualized reading programs. The author feels that it is the researcher's job to find out more about these processes so that research could move from the laboratory into the classroom. References are included. (AW)

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Implications of Information Processing to Reading Research*

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My own introduction to the psychology of the reading process was in a course I took at the University of California, Berkeley, in 1960-61. It was a very good course, taught by Jack Holmes and using the reasonably new text by Anderson and Dearborn, The Psychology of Teaching Reading. At least it was a very good course for Irene Athey and I who were the only full-time doctoral students in the class. It was much less useful for the other members of the class who at each class meeting already had behind them a full day's teaching, a commute over a California freeway, a frantic search for a parking place and who had arrived just in time for the 4:30 slump. For them, the discussions of Zeitler, Cattell and other 19th century scholars were something less than useful and a good deal less than exciting. But the scholar-practitioner model of teaching, developed during those bright days when science promised to answer all questions, was in full swing and such theory courses were considered essential to the teacher. As Anderson and Dearborn made clear in their preface, the research they so thoroughly reviewed "has thrown light on the fundamental nature of the reading process and the results permit immediate classroom application" (p.iii).

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So there was the goal: to present the results of basic research to teachers so that immediate classroom applications could be drawn. The results presented, however, were largely from studies conducted at or before the turn of the century. The tone of the writing was that the major questions had been answered, although such late-comers as Tinker and Buswell had filled in some details as late as the 1930's. To doctoral students, therefore, the course and the text should have been a bonanza. Surely psychology had produced something of interest to reading since the days when Cattell had hung up his tachistoscope, and in these areas must exist many potential dissertation topics. Irene found much of interest in the work of Ericksen and of Piaget. I was fortunate in finding rather early in my search a new book by D. E. Broadbent entitled Perception and Communication (Broadbent, 1958). This book, one of the seminal benchmarks in the streams of thought beginning to coalesce into the information processing point-of-view, made it clear on one reading that Anderson and Dearborn's views of the reading process were as obsolete as the research upon which it was based.

I have dwelled on my experiences because I think they largely mirror the experience of many of us over the past decade and because they bear importantly on the major implication for reading research which I find in reviewing information processing models of the reading processes and of processes related to reading. It is time we lay to rest the concept of the reading teacher as scholar-practitioner, in so far as basic research is concerned. If we do not, we will be condemned to spending more

decades finding no differences between Method A and Method B and researching interminably such trivia as whether letter names should be taught in kindergarten. I will discuss this implication in some detail below.

Before discussing implications, however, I think it would be useful to review generally the information processing viewpoint. I have written a rather long paper for the final report of the Literature Search Project (Davis, 1971) which overviews a selection of some 45 models, most of which are of the information processing type. This paper, plus the papers of those scholars who did the basic reviews in the area of the reading process will comprise the summer edition of the Reading Research Quarterly (Geyer, in press). Since this material will soon be available in print and because the time allotted to this presentation is not adequate for even a cursory examination of any single model, I will restrict myself here to a brief examination of the general viewpoint which constitutes the coalescing field of information processing.

Definitional to the information processing viewpoint is the idea that perception requires time and that during that time the sensory input is subjected to complex processing occurring at multiple stages by which it is "transformed, reduced, elaborated, stored, recovered, and used" in a variety of ways (Neisser, 1967). The psychologist holding this viewpoint is interested, therefore, in (1) how the organism processes information and in (2) what happens to the information during such processing. But the information processing viewpoint, as I am using the term here,

is by bo means restricted to psychology. It is an actively developing viewpoint which cuts across traditional academic boundaries and includes elements from such additional fields as linguistics, the neurosciences, computer design, programming and simulation, electronic and communication engineering, and such boundary disciplines as psycholinguistics . psychobiology, human factors research, bioengineering, etc. I know of no more dramatic an example of the cliché that knowledge does not exist in three-unit packages, for the dynamic interaction of traditional disciplines we are not witnessing is a direct result of knowledge bases which have expanded to the point where such interaction between traditional disciplines is not only possible but necessary. Information processing is one viewpoint which many scholars find a useful framework within which such dynamic interactions can take place.

What has this to do with the reading processes? Reading is a chief form of information processing in literate societies and it is the form which utilizes the visual modality. Of all the sensory modalities, vision has long held the first place in scientific interest and more by far is known about visual processes than about any other modality. It was inevitable, therefore, that scientists interested in information processing should study processes which were components of or closely related to the reading process. Indeed, it is a recent and growing phenomenon for such scientists to turn their attention to the reading processes <u>per se</u>. If you believe, as I do, that a sophisticated understanding of how such processes are learned---

If you believe, as I do, that a richer understanding

of how reading is learned would be a fruitful source of insights on how that learning might be aided---then this coalescing of disciplines around information processing simply cannot be ignored. For it is in the nature of things that when disciplines coalesce, knowledge is not increased incrementally --- rather, large masses of structured, technical knowledge suddenly become potentially relevant. This can be overpowering to the individual scholar and the temptation is to throw up one's hands and to tut-tut about its lack of usefulness to the first grade teacher. A better alternative, it seems to me, is to define those areas of greatest interest and potential usefulness and to structure them through model building. For a model allows one to structure the whole, tentatively, and to work on the details of the parts without losing sight of that whole.

The dimension of information processing which is of most interest to me is found in those models of the reading processes and of such components as attention, memory, etc. which seek to delineate the organismic systems operating between input and output at a psychological level. These I have called O'-type models (Geyer, 1971a, 1971b). There are a number of them and they differ importantly in their details. The areas of agreement, however, are impressive. All postulate a complex sequence of information processing and storage systems. Most assume a hierarchical processing structure with very rapid initial systems subordinated to subsequent systems operating over longer time intervals. Short term stores function as temporal buffers between processing systems.

Complex and little-understood feedback pathways facilitate integration of the systems and even less-understood pathways to and from long-term memory monitor the information flow.

Reading as outlined in these models involves the continuous integration of numerous on-line systems and off-line memory stores. Each of these systems and their integration is a subskill of reading and learning to read must involve a mastery of each subskill to an automatic level as well as accumulating in long term memory the information necessary to the extraction of meaning. Many of these subskills are familiar to reading teachers. We would distrust the models if this were not so. But some processes are unfamiliar and are not taught directly. With verification and agreement, such unfamiliar processes should add genuinely new dimensions to the teaching of reading. These models could provide a much more precise basis for diagnosis and remediation and could well serve a taxonomic function for the structuring of individualized reading programs. Yet I do not believe that the major contribution of the O'-type models will be directly to reading instruction. The major contribution will be to serve as a seminal focus for further research in a variety of disciplines. I shall illustrate this point more fully below.

The second dimension of information processing, the S' dimension, concerns the transformations of the information itself which convert it from a pattern of light and dark into meaningful language of a form appropriate to the intended output. Perhaps best known are the developing psycholinguistic models of reading, but models on this dimension derive from a

number of disciplines also concerned with detailing the coding and memorial processes involved at various stages of the information flow. At present, these models show little agreement and the nature of the units and transforms involved are little understood. Yet the sophistication with which the complexities involved are being outlined has advanced us a long ways from the Victorian science still found in much professional reading literature. In place of the instantaneous response to general word shape suggested by Cattell in 1887, today's thinking finds complex series of transformations, utilizing information stored in long term memory to convert subordinate units from input levels to the larger units appropriate to the meaning content.

The widespread interest in language processes today attests to the potential an understanding of these processes has to reading research and practice. Reading is a language skill and it will be this dimension which will contribute most directly to new curricula. However, the most useful knowledge concerning complex language processes will be that interfacing with the organismic systems and processes involved. I would expect, therefore, significant advances in our understanding of language processes to <u>follow</u> the delineation of the O' processes and to benefit from the subtle experimental procedures which have characterized the activity in this area.

The distinction between the O' and S' dimensions is merely a logical device helpful in analyzing model components. In nature, of course, these dimensions are interwoven in the same processes. Yet models with one or the other emphasis tend to

differ systematically. Those concerned with O' processes typically see information processing as a decoding process involving systems which passively receive information for analysis. Models detailing the S' dimension, however, emphasize expectancy aspects and postulate processes which are active, synthetic and constructive. One of the important reasons for the passivity of the O' models, in my opinion, is that they are based on psychological presuppositions derived from a neurology which is itself in the midst of rapid change. For this reason, breakthroughs in neurology and psychobiology could provide the necessary bases for synthesis.

For example, a major research focus today seeks to discover the nature of selective attention. There is reason to believe that selection in vision may begin with very rapid input processes quite different from the passive projections to the cortex assumed by classic neurology. Some years ago I reported an initial model of the reading processes which postulated an active input system capable of several input strategies (Geyer, 1966, 1968). In reading-related tachistoscopic situations, three input strategies could be hypothesized, (1) a diffuse attending to a broad visual field, or (2) a focused visual field with a rapid scanning input from left-to-right in reading English, and (3) from right-to-left in reading Hebrew. Since central processes must be involved in discriminating English from Hebrew in bilingual subjects, this hypothesis logically required efferent fibers connecting cortical language centres to more peripheral visual mechanisms. The existence

of such fibers is a major neurological controversy (e.g. Sokolov, 1963; Zopf, 1963) and this rather radical hypothesis must await further evidence. However, the cortical areas responsible for widening and restricting the visual field have recently been reported (Pribram, 1971). A theory of visual pattern perception suggesting a similar attentional scan has been advanced from the viewpoint of bio-engineering on the basis of new eye movement measurement techniques (Noton, 1970). That the attentional point of regard is not optically fixed to the saccadic point of fixation as long assumed has become well-accepted largely due to research with fixed retinal images (Moray, 1970). Thus, the evidence for active input processes in vision is accumulating from a variety of disciplines. If such processes prove to be fact, the relationship between the feature-detection decoding models and the insistence by psycholinguists that only fragments of text are needed to confirm expectancy will be much clearer. When that happens the relationship of <u>these</u> processes to adjacent processes such as iconic storage will be clarified as well.

I have tried to indicate briefly today the rapid coalescing of basic disciplines around a point of view with rich relevance to the reading processes and ultimately to learning to read. Since I hold the view that basic, theoretical research is in the long run the most practical, productive and relevant, I believe that educational researchers interested in the reading processes have a responsibility to move this research to useful ends. There is one major hindrance to this happening: The

the archaic doctrine that all research be immediately applicable to the classroom. For example, following a superficial discussion of Chomsky and Lenneberg, a writer on the February 16 Report on Educational Research had this to say in a review of the Final Report of the Literature Search Project:

> If you are wondering whether the typical first-grade reading teacher will ever benefit from such esoteric controversy, you're not alone. Even one of the project coordinators, Joanna P. Williams ..., frets because reading theories and models are in danger of becoming too sophisticated to be of any practical help in the classroom (P.5).

While Joanna may wish to disagree with the writer's interpretation of her article, the attitude he presents is extremely prevalant in education, In my view, it is exactly wrong: our understanding of the reading processes as represented by today's models is not nearly sophisticated enough and they were never intended for direct application to the classroom. Rather, they serve the function of any theory: as a badly needed source of seminal ideas from which whole lines of research may follow. In this case, each line of research has the potential of developing some genuinely new ideas for curriculum development.

Let me illustrate by examining one component of one model. If we pretend for a moment that the type of active visual input my model hypothesized is verified and accepted, what then could I tell the reading teacher? I could tell her that she must emphasize that words are read from left to right and that she must train children until they do this habitually. Children who fail to master this subskill of reading can be expected to block badly and to occasionally read reversible words as if they were printed backwards. She would tell me, of course,

that she has known this for some time and she didn't need my theorizing to tell her that.

The problem, of course, is not with the model or the teacher. The problem is that by relating the model directly to the classroom, several important stages of research were short-circuited. The model should have been used to generate research questions such as the following:

What are the neurological concomitants of this input skill? Is it related to the old controversy concerning mixed dominance? Can it be measured directly, perhaps through evoked potential techniques? What proportion of disabled readers manifest difficulties with this system? How does the skill develop? To what extent is it prewired and to what extent learned? What early visual experiences are necessary or beneficial in the development? Does a failure in the development of this skill retard the development of subsequent systems? Do sociological or nutritional factors effect the development? If the difficulty is congenital, what alternate input strategies are used and can they be utilized in reading instruction? If the difficulty is reversible, what training procedures are most effective? It is the answers to these questions which will have relevance to reading instruction.

I would submit that these are a few of the questions which should be derived from one component of a model of the reading process. The answers can only come from lines of research starting in the laboratory and ending in the classroom with developed curricula and techniques. Much of this research must

necessarily be interdisciplinary as the technical sophistication of the fields involved is considerable. The strength of the information processing point-of-view is its strong tendency to cut across discipline boundaries and its probable effectiveness in moving research from laboratory to classroom. The reading teacher stands at the final stage-at the point between developed curricula and the learner. It is our job--not hers--to span the rest of the distance.

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